Scanning Gate Microscopy on low-dimensional nanostructures

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In my talk I will review our Scanning Gate Microscopy (SGM) activities performed at the NEST laboratory in Pisa, Italy, which in the last years were mainly focused on two-dimensional electron gas systems (2DEGs) in III-V semiconductors.

The origin of the anomalous transport feature appearing at a conductance $G \approx 0.7 \times (2e^2/h)$ in quasi-1D ballistic devices, the so-called 0.7 anomaly, represents a long standing puzzle. Several mechanisms have been proposed to explain it, but a general consensus has not been achieved. Proposed explanations have been based on quantum interference, the Kondo effect, Wigner crystallization, and other phenomena. A key open issue is whether the point defects that can occur in these low-dimensional devices are the physical cause behind this conductance anomaly. Here we use the SGM technique to map individual impurity positions in several quasi-1D constrictions and correlate these with conductance characteristics. Our data demonstrate that the 0.7 anomaly can be observed irrespective of the presence of localized defects, and we conclude that the 0.7 anomaly is a fundamental property of low-dimensional systems [1].

Furthermore, ongoing reserach on 2DEGs with superconducting contacts will also be discussed.

Very recently we have also started to work on graphene and other 2D materials. I will present some first results on graphene nanoribbons [2] and split-gates realized with single-crystalline CVD-grown graphene [3,4].

[1] A. Iagallo, N. Paradiso, S. Roddaro, C. Reichl, W. Wegscheider, G. Biasiol, L. Sorba, F. Beltram, and S. Heun: Scanning gate imaging of quantum point contacts and the origin of the 0.7 anomaly, Nano Research 8, 948 (2015).

[2] A. Mrenca-Kolasinska, S. Heun, and B. Szafran: Aharonov-Bohm interferometer based on n- p junctions in graphene nanoribbons, Phys. Rev. B 93, 125411 (2016).

[3] V. Miseikis, D. Convertino, N. Mishra, M. Gemmi, T. Mashoff, S. Heun, N. Haghighian, F. Bisio, M. Canepa, V. Piazza, and C. Coletti: Rapid CVD growth of millimetre-sized single crystal graphene using a cold-wall reactor, 2D Mater. 2, 014006 (2015).

[4] S. Xiang, V. Miseikis, L. Planat, S. Guiducci, S. Roddaro, C. Coletti, F. Beltram, and S. Heun: Low-temperature quantum transport in CVD-grown single crystal graphene, Nano Research, in press, DOI 10.1007/s12274-016-1075-0; arXiv:1603.07499 [cond-mat.mes-hall].